

the typical habitat and substrate type found in the study area. The transects were placed perpendicular to shore. Transect A (the southern most transect) was 200 m in length. GPS coordinates were taken at the shoreward, or starting point (S-0) of the transect (0 m MLLW), midpoint (S-100), and endpoint (S- 200) of the transect (-3.5 m MLLW). Transect B (the northern transect) was 100 m in length with GPS coordinates taken at the starting point (N-0) of the transect (-0.5 m MLLW) and endpoint (N-100) of the transect (-2.0 m MLLW). At 10 m intervals along the transect line, divers took notes underwater on visual observations of substrate type, percentage of *Zostera marina* coverage, the type of cover (sparse, dense, continuous, patchy), and information on observed macroalgae and invertebrates. These data were used to verify the video observations and were compared with the final mapped polygons for accuracy.

As a check of the positional accuracy of the side scan sonar record, SCUBA divers located and marked the outer edges of a pre-selected eelgrass meadow with tethered buoys in Area E that had been delineated on the sonar record (Figure 4). The buoy coordinates were then determined using GPS and compared with the sonar record for positional accuracy.

## **2.2 Data Analysis**

Data analysis included post-processing of field records (e.g., video, side scan sonar, visual observations) in a geo-referenced format that was used for the development of GIS maps delineating the substrate type and eelgrass and kelp coverage. The videotapes were further post-processed for macroinvertebrates, macroalgae, and fish, leading to GIS coverages of track lines with georeferenced positions of fauna and flora.

A quality assurance/quality control (QA/QC) assessment was conducted on the post-processed video footage to ensure accurate representations of the data (see Section 3.6)

#### 2.2.1 Videography post processing

There were five primary habitat/species categories that were analyzed on the videotapes:

- substrate
- eelgrass
- macroalgae
- fish
- macroinvertebrates

Each of these primary categories was further subdivided based on distinguishing characteristics representative of the category, such as percentage of cover (eelgrass), substrate type, presence or absence of selected algal species, species identification, size, density and the number of individuals. Details of each classification category are described below.

##### 2.2.1.1 Video Analysis

An Excel spreadsheet captured time and position data every 1 to 3 seconds in the field at the same time the information was captured on videotape. During post-processing, this data was entered into a template containing the header information for the five primary categories and sub-categories (Appendix A.1). As files were post-processed, they were combined for each area to import into GIS mapping software. A post-processing log sheet (Appendix A.2) was completed for each track line file of data,

which contained file header information as well as anecdotal notes (e.g., turbidity in the water column, camera off the bottom, missing navigation data).

Video post-processing was conducted in several stages because of the numerous categories of biological and physical data analyzed. Initial post-processing included identification of eelgrass cover, substrate type, several types of macroalgae, and the presence of fish. The identification and enumeration of fish species was done separately as a second phase of post-processing. The final phase included assessment of total macroalgal cover and macroinvertebrate identification.

During post processing, the video monitor screen was divided in half horizontally with a thin line of tape. Eelgrass, macroalgae, substrate type, and macroinvertebrate classifications were recorded from the lower half of the monitor (i.e., closer to the camera). This viewing area ranged between approximately 1.5 and 4.2 square meters for the video transects parallel to shore and slightly less than 1 square meter for the transects perpendicular to shore. This reduced the subjective bias of the observer in classifying data that was a distance from the camera, and also allowed the observer to see what was coming into view before having to make a classification call. By alerting the observer to oncoming changes in categories, it allowed the tape to be stopped and data entered into the spreadsheet before changes occurred.

Fish were analyzed and classified using the entire screen. Since fish are mobile, some species only occurred at a distance and then moved out of the screen's view. This was particularly true for schooling species. Although fish at a distance could not be as readily identified to species, it was felt that these data were important to record to the nearest class.

During post processing, if data gaps were found in the videotape, the corresponding spreadsheet information with the position, time, and date stamp were omitted from further analysis as well. If there were less than or equal to, a 30-second gap in the video observation of the bottom (due to the camera being a significant distance off the bottom), and there were no recorded change in the dominant classifications before and after the gap, the data were determined to be useable. This situation occurred almost exclusively at the deeper depths (close to -30 m MLLW), where eelgrass was not found, and a change in substrate seldom occurred. If there were questions in the determination of a classification, a second independent observer reviewed the classification as well.

#### 2.2.1.2 Classification Scheme and Codes

For each habitat or substrate type, a coded classification scheme was implemented to identify the video observation in a spreadsheet format. The general categories, represented as columns in the spreadsheet, are shown in Table 1. More detailed information indicating the corresponding GIS field header information and definitions is presented in Appendix B.

*Eelgrass* – Eelgrass (*Z. marina*) habitat was assessed and classified using a modification of a semi-quantitative system used in Chesapeake Bay (Orth et al., 1997) to monitor seagrass coverage annually. This method estimates eelgrass density (percentage of cover) by visually comparing the bed with an enlarged Crown Density Scale similar to those developed for estimating crown cover of trees from aerial photography (Paine 1981). We have modified this system somewhat to accommodate our underwater video data collection method (Table 2).

**Table 1.** Classification Categories Used for Underwater Video Post-processing

Category	# of Codes	Type of Code
Eelgrass	4	Density (% cover)
Dominant Substrate	5	> 50% dominant surface cover
Substrate Presence	6	>10% <50% surface cover
Artificial Substrate	9	Man made surface cover
<i>Nereocystis luetkeana</i>	2	Presence/absence
<i>Sargassum muticum</i>	2	Presence/absence
<i>Ulva spp.</i>	4	Density (% cover)
Fish Presence	2	Presence/absence
Fish Species ID	22	Identification
IND <sup>1</sup> /SCH <sup>2</sup>	2	Behavior type
Fish density	4	Density
Number of fish	0 to >100	Total individuals
Macroalgae	4	Density % cover
Sea pen density	4	Density
Invertebrate Presence	2	Presence/absence
Invertebrate Species ID	12	Identification
IND <sup>1</sup> /AGG <sup>3</sup>	2	Behavior type
Invertebrate Density	4	Density
Number of Invertebrates	0 to >100	Total individuals

<sup>1</sup> IND=individual<sup>2</sup> SCH=school<sup>3</sup> AGG=aggregate**Table 2.** Eelgrass (*Zostera marina*) Classifications

Code	Description
0	0-10%; none to sparse coverage
1	10 – 50%; moderate coverage
2	>50%; dense coverage
3	Edge of dense bed or dense patches

The development of the estimations of eelgrass coverages was based on several inherent assumptions about the video data. Our camera angle of view was oblique when recording video data on track lines parallel to shore. It was not always easy to distinguish edges of dense beds that were closely spaced from contiguous beds. Therefore, “Category 2 - >50%” included dense patches or contiguous beds. If, however, an edge of a dense bed was distinctly visible or a single patch was dominant in the field of view and represented >10% of the viewable area of the bottom half of the screen, then it was classified as “Category 3 – edge” and over-rode Categories 1 and 2”. An assumption was also made when operating in deeper water (25 m to 30 m) that eelgrass did not exist at this depth (Thom et al., 1998). These were generally areas where the “30-second gap” rule was employed (see Section 2.2.1.1; an assumption was made that eelgrass was not present and the area was categorized as 0).

**Substrate**—There were three major categories of substrate type that were classified: Dominant Substrate, Substrate Presence, and Artificial Substrate. The substrate classifications were adapted from *Marine and Estuarine Habitat Classification System for Washington State* (Dethier 1990). Dominant Substrate and Substrate Presence shared the same codes (Table 3) with the exception of shell hash that was added to the Substrate Presence category. Dominant Substrate occupied a majority of the viewable screen (>50%). If a second substrate type was present and identified in the same frame (between 10% and 49%) it was recorded as Substrate Presence. The category codes range from 2 through 7. Originally, Code 1 was mixed fines; however, because of the difficulty distinguishing between sand and mixed fines in the video, it was incorporated into Code 2 - Sand.

**Table 3. Dominant Substrate and Substrate Presence Classifications**

Code	Description
2	Sand—0.6-4mm. What appears visually to be sand and mixed fines
3	Gravel—Small rocks or pebbles, 4-64mm diameter
4	Mixed Coarse—consisting of cobbles, gravel, shell and sand (none exceeding >70% surface cover)
5	Cobble—rocks < 256mm (10 ") but > 64mm (2.5") diameter
6	Boulder—rocks > 256mm
7	Shell hash <sup>(a)</sup> —complete or fragments of shell

(a) Used for substrate presence only

The third substrate category was defined as Artificial Substrate. This was generally reserved for man-made items either placed intentionally or unintentionally on the bottom. An item was included if it encompassed >10% of the bottom half of the viewable screen. Additional explanations about items were added as notes to the spreadsheet during post-processing.

**Table 4. Artificial Substrate Classifications**

Code	Description
c	Concrete blocks
t	Tires
b	Bulkheads
r	Riprap
l	Logs
pl	Pilings—concrete or wood
w	Woody debris
p	Pipe
j/o	Junk /other-- man made items and/or items identified as noteworthy of reporting such as crab pots